

Lin, P. J. (2004). Enriching opportunities for assessment integral to instruction through assessment tasks along with students' responses to the tasks. Paper presented at the 10th International Congress on Mathematics Education (ICME-10, TSG27). July 4-11, Denmark: Copenhagen

Enriching Opportunities for Assessment Integral to Instruction Through Assessment Tasks Along with Students' Responses to the Tasks¹

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Abstract

The study was designed to assist teachers designing the assessment tasks and help them analyze students' responses to the tasks. Ten classroom teachers and the researcher collaboratively set up a school-based assessment team in a two-year Assessment Practices in Mathematics Classroom project that assists teachers in implementing assessment as integral part of instruction. The assessment tasks along with students' responses to the tasks and classroom observation were major methods of data collection. One of four categories of assessment tasks created by the teachers was for improving students' ability of formulating problems. Interweaving the tasks with analyzing students' responses to the tasks was a valuable way for enriching opportunities of assessment integral to instruction

Introduction

The new vision of assessment standards of several countries suggests that classroom assessment must be concerned with much more than its traditional focus on testing and grading (Clarke, 1989; MET, 2000; NCTM, 1995). The assessment movement emphasizes the role of classroom assessment in gathering information on which teachers can base their subsequent instruction. Therefore, formative assessment associated with processes and informal assessment associated with purposes have increasingly come playing a key role in teaching. Knowing how these assessment processes take place should become a focus in teacher education programs.

The reformed curricula suggest that students should be given opportunities to foster ways of acquiring and using content knowledge such as formulating problems from situations, communicating mathematics with understanding, and justifying other's conjectures (NCTM, 1995; MET, 2000). These documents call for classroom assessment should not focus on specific and isolated skills. Instead, increased attention should be given to observing, listening, and questioning students, both to assess students' mathematics with understanding and to gain insight into their beliefs about mathematics. As mathematics reform has proceeded, the task of assessment integral to instruction has become one of the more promising tools for assessing

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students' understanding of mathematics. Thus, the increased emphasis in teacher education program should be placed on teachers' responsibility for the quality of the tasks in which stimulate students' high quality thinking (NCTM, 1995).

To assess students' knowledge and understanding, teachers must seek evidence to confirm if their intuition during incidental occurrence of student insight. The quality of evidence available to a teacher to assess such information depends on the tasks a teacher designs. Effective classroom assessment practice requires gathering evidence from a variety of sources, some of which is best delivered through students' work. To design more engaging, active, and open tasks that require students to make choices among strategies, reason, and explain become as a major concern when teachers create an assessment task (De Lange, 1995; Heuvel-Panhuizen, 1996).

The design of high quality of assessment tasks is a very complex and challenging work for the teachers who are used to the traditional test. This can only be achieved by establishing an assessment team who support mutually by providing them with the opportunities for dialoguing on critical assessment issues related to instruction. The tasks involved in the previous studies on new approaches to instruction and assessment were administrated as a part of ongoing classroom activity for assessing students' thinking either during or after instruction (Chambers, 1993; Lambdin et al., 1996). However, it is not adequate that the tasks are administrated merely during instruction to understand how each student thinks according to her or his natural way of thinking or ability in a typical classroom with thirty to thirty-five students. Thus, there is a need to extend the use of tasks to know each individual student learned about mathematics in each lesson. This indicates that teacher education programs should build teachers' new experience and needed support in designing lesson-lesson assessment tasks. The lesson-lesson tasks were designed to examine how each individual student learned about mathematics from today lesson and to inform further instruction for next day lesson based on students' responses to the tasks.

The study focused on developing teachers' knowledge of new vision assessment integral to instruction, designing assessment lesson-lesson tasks, and analyzing students' written work, as an aspect of assessment integral to instruction, to inform their decision-making of teaching. The lesson-lesson assessment tasks were generated from the lesson. Thus, the mathematics contents covered in the textbooks were used as a dimension of assessment framework of the study. Reformed curricula suggest that

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high quality of tasks should help students clarify their thinking and develop deeper understanding through formulating problems, communicating mathematics with understanding, and justifying other's way of thinking (MET, 2000). Thus, formulating problem, communicating mathematics, justifying one another's thinking were considered as the other dimension of the assessment framework of the study.

Tasks defined by the Standards are the problems, the questions, and exercises in which students engage (NCTM, 1991, p.20). Tasks could be administered either during instruction or at the end of the instruction. Tasks referred to the study included the problems in which students engaged collected in the students' journal, as an informal way of assessing if students understood the mathematics ideas and students' various solutions exhibited in today's lesson. Thus, the lesson-lesson tasks were not well prepared prior to today's lesson. Rather, they followed immediately after today's lesson. Analysis defined by the Standards is the systematic reflection in which teachers engage (NCTM, 1991, p.20). Analyses referred to in the study included the reflections teachers made to monitor how well the tasks were able to foster thinking mathematically for students and to analyze what students responded to the tasks were able to inform further instruction for teachers.

The Assessment Practices in Mathematics Classroom Project

The goal of the Assessment Practices in Mathematics Classroom (APMC) project funded by National Science Council was to assist teachers to explore their understandings about how students develop their understanding of mathematics, and how this can be supported through the program. To reach the goal, teachers were encouraged to use students' journal as a way of gathering the information about students' thinking processes, strategies to aid them in decision-making. The assessment tasks referred to in the study as the prompts of students' journal, since we wanted to establish a better means of communication among students, parents, and teachers about the kind of mathematics learning taking place in classrooms. We were looking for a better way to assess each student's entire learning process by writing about mathematics.

In generating tasks, the concerns included that: 1) supports a method of assessment that allows students to demonstrate their strengths rather than their weaknesses; 2) stimulates students to make connections for mathematical ideas; 3) poses good tasks that do not separate mathematical thinking from mathematical

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concepts; and 4) generates the assessment lesson-lesson tasks for inspecting what and how students learned from today's lesson. The assessment tasks can be done for students either at home or at school. To generate the high quality of the tasks in a limited time and to answer the tasks for students, the tasks included one or two items were reasonable.

The philosophy of the APMC project was based on social constructivists' view of knowledge, in which knowledge is the product of social interaction via dialects in a professional community (Vygotsky, 1978). Therefore, activities related to generating assessment tasks were structured to ensure that knowledge was actively developed by the teachers, not imposed by the researcher. The assessment tasks were generated in a cyclic way: starting to classroom to observe a teacher's teaching, conducting a task by the instructor, bringing students' responses to the task to the weekly meeting for discussion, and bringing the information back to classroom to examine and to inform further instruction. Thus, the teachers were frequently involved in observing teaching together, dialoguing as a group, and reflecting on the quality of tasks. There was a research question to be answered: How assessment tasks do teachers use in supporting their understanding of students' learning mathematics and then inform their classroom decision-making?

Methods

To achieve the goal of the study, a school-based "assessment team" consisting of the researcher and classroom teachers was set up to discuss the assessment issues which occurred in one teacher's classroom by comparing to others. The ten teachers were divided into three subgroups according to the three grades, when we read and analyzed students' responses to the tasks administrated in their classrooms.

The same mathematical content lent itself to a focus and similar pedagogical issues addressed drew attention from each teacher, leading to in-depth discussions. Thus, three grade classrooms were the primary contexts for teachers learning to design tasks. Arena for regular weekly meetings was the other primary context for the teachers. The three second-grade teachers were P2, Q2, and R2 and four third-grade teachers were A3, B3, C3, and D3. The three fourth-grade teachers were X4, Y4, and Z4. Their teaching experiences were ranged from 3 to 16 years. The role of the researcher was not to provide ready-made tasks to use, but to create the opportunities for teachers sitting together to design creative assessment tasks for students.

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The teachers had little knowledge of assessment integral to instruction, so that classroom observation was used as a means of increasing teachers' awareness of generating assessment tasks in which were initiated from the lessons that the teachers observed together. The routine weekly meeting lasted for three hours. The meetings gave the teachers opportunities to share creative tasks mutually and helped them to rethink how well the tasks for gathering information of students' in-depth understanding. The major concern as designing a task was that students are allowed to show what they are able to do. At the very beginning of the study, the researcher encouraged them to create at least an assessment task integral to teaching each week. Because the use of tasks was to promote students' understanding rather than just for the work, the following questions were supplied to nudge teachers to rethink: What do you expect to learn about your students from this task? Are you satisfied with your students' performance on the task? Did you really gain what you want to gather from the task? Besides, each teacher needed to report in the meeting what they learned from the tasks and what information they gained from students' responses to the tasks.

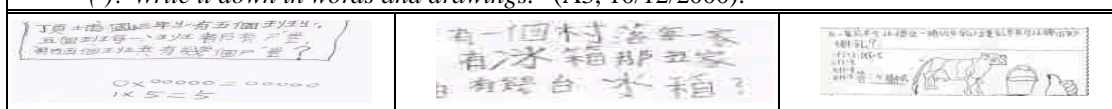
Assessment Tasks and Students' Responses to the Tasks

Four categories of assessment tasks created by the teachers were for improving students' ability of formulating problems, for increasing students' attention on learning mathematics with understanding, for improved students' abilities to communicate their thinking, and for facilitating students' critical thinking. Each assessment task was developed by teachers' mutually supports and modified by doing throughout the entire study. The limitation of the space, the tasks associated with multiplication for facilitating students' ability of formulating problem is described here only. The other three categories of the tasks will be reported in other paper.

Task 1: Giving a number sentence to create a word problem

At the very beginning of the study, a typical category of the tasks for facilitating students to pose a problem was given by a number sentence. For instance, the following task administrated by the teacher A3 was to examine if her students make sense of the meaning of multiplicand 1. This task provided students the opportunity of formulating a problem but also helped A3 to trace her students' learning trajectories. .

Task: *If you were a teacher, how would you give your students a problem situation represented by $1 \times 5 = ()$? Write it down in words and drawings."* (A3, 10/12/2000).



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Wu's response: English version	Hei's response: English version	Sue's response: English version
There are five third-grade classes in Din-Pu School. There are clocks in each class. How many are clocks there altogether?	There are freezers in each house. How many are freezers in the five houses located in a tribe?	A cow produces a bucket of milk. How many buckets of milk do 5 cows produce totally?

Figure 1

Figure 2

Figure 3

Before conducting the task, A3 said that her students were supposed to understand well the meaning of multiplication according to her intuition during occurrence of students' performance in class. After analyzing students' responses, she reported to us that the analysis of the task helped her to perceive 11 of her 35 students still having the difficulty with the meaning of the multiplicand 1. In the textbook of Taiwan, $5 \times 1 = ()$ referring to "a group of 5"¹. In Figure 1 and 2, Wu and Hei had the same trouble with the multiplicand 1 as the number of each set, As Wu explained "1" for $1 \times 5 = ()$ by "each class has clocks" instead of "each class has a clock".

One of the third-grade teachers, B3 recommended A3 bring one of the two improper problems to classroom to ask students to repair it. Next day, A3 acted as though she needed help and then asked students, "Is it wrong? [*There are five third-grade classes in Din-Pu School. There are clocks in each class. How many are clocks there altogether?*]. Could you help me to repair it so that it can be solved?". As observed, the majority of students devoted to repairing the improper problem.

The task associated with problem-posing allowed A3 to gain insights into the way students constructed mathematical understanding. The task was able to gather the information of students' cognitive levels. Furthermore, the improper problems that students gave as an indicator of their unclear conception can be made profitable when asking students to repair them and inform teachers making instructional decision. Thus, helping students to clarify their misconceptions or improper problem given by students responding to the tasks became a common work for the teachers at the very beginning of each lesson.

Teachers supported each other in such a way; thus, in the midway of the study, they conducted more complexity of assessment tasks such as given a picture or mathematics language to ask students to create a word problem. The task 2-1 referring to a picture or drawing to formulate a mathematical problem was conducted by the teacher P2 for second graders to assess if her students understood the meaning of

¹ The textbook of Taiwan dealing with "A set of 5 apples" as "one five" "five times one" " $5 \times 1 = ()$ " is not consistent with those of U.S.A

Lin, P. J. (2004). Enriching opportunities for assessment integral to instruction through assessment tasks along with students' responses to the tasks. Paper presented at the 10th International Congress on Mathematics Education (ICME-10, TSG27). July 4-11, Denmark: Copenhagen multiplication through creating a word problem.

Task 2: Giving a picture or a drawing to formulate a word problem

In the second day of the lesson, the teacher P2 posed the problem 3 in which Horng responded to the task, "There are 7 bugs, and each bug has 6 legs. How many legs are there altogether?" shown in Figure 4. P2 asked her students to write it as a number sentence in the class. During the class, Horng put his more attentions to see if his problem can be solved by his classmates. After scoring the task, the teacher P2 found that 8 out of her 32 students still had the difficulties with the expression of $6 \times 7 = ()$ instead of $7 \times 6 = ()$ (Observation, 04/03/2001).


	<p>Task2-1 (For second graders): This is a picture about the princess and 7 dwarfs. If you were a teacher, what word problem would like to pose? (P2, 03/29/2001)</p>
<p>Horng's responses:</p> <ol style="list-style-type: none"> 1. There are 2 mice. Each mouse has 2 legs. How many legs are altogether? 2. There are 4 flowers and each has 5 pieces. How many pieces are there? 3. There are 7 bugs, each bug has 6 legs. How many legs are the bugs altogether? 4. Every one has 2 eyes. How many eyes are there altogether? 	

Figure 4

To help those students who had the difficulty with the distinction between $6 \times 7 = ()$ and $7 \times 6 = ()$ under the situation. Again, at the very beginning of the teaching in the third day lesson, P2 helped her students to clarify their difficulty by distinguishing "6 sets of 7 means 7 times 6 and described as $7 \times 6 = ()$ " from "7 sets of 6 means 6 times 7 and described as $6 \times 7 = ()$ ".

The task 3 shown in Figure 6 conducted by P2 was followed immediately the class to assess if her students understood the meaning of multiplication.

Task 3: Giving a mathematical language to formulate a word problem


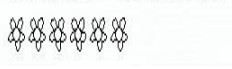

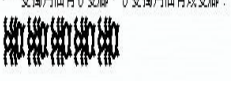
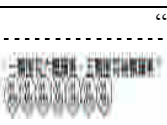

Task:	(1) Draw a picture and create a word problem for "6 sets of 5". (2) Draw a picture and create a word problem for "5 sets of 6". (Q2, 04/03/2001)			
Shei's response		<p>"5 sets of 6". Each ant has 6 legs, How many legs do 5 ants have altogether?</p>	<p>"6 sets of 5" 一朵花有5個花瓣，6朵花有幾個花瓣? </p>	<p>"6 sets of 5" There are 5 flowers; each of them has 6 pieces. How many are pieces of flowers there altogether?</p>
Chiao's response		<p>"5 sets of 6". There are 6 flowers; each of them has 5 pieces. How many pieces of flowers are there altogether?</p>	<p>"6 sets of 5" 一隻獨角仙有6隻腳，5隻獨角仙有幾隻腳? </p>	<p>"6 sets of 5" Each ladybug has 6 legs. How many legs do 5 ladybugs have?</p>
Wei's response		<p>"5 sets of 6". There are 6 apples in each tree. How many apples do 5 trees have?</p>	<p>"6 sets of 5" 一盤有5個餅乾，6盤有幾塊? </p>	<p>"6 sets of 5" Each dish has 5 crackers. How many crackers are in the dishes altogether?</p>

Figure 6

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The teacher P2 brought students' work to the weekly meeting to analyze with other teachers'. Her students' responses to this task were categorized into as the examples of Shei's, Chiao's, and Wei's responses, shown in Figure 4. With the exception of two students, the others answered correctly. Shei understood well the distinction between "6 sets of 5" and "5 sets of 6" terms whatever it was displayed in a picture or a word problem. Chiao was successful to explain the meaning of multiplication by a drawing, but he failed in creating a word problem. On the contrary, Wei had the difficulty with drawing to represent the number sentence of multiplication. Based on the classroom observation and professional dialogues in weekly meeting, the teacher Q2 next to the P2's class finally perceived that the significance of understanding the meaning of multiplication for the second graders.

Conclusion

The study concluded that designing assessment tasks along with analyzing students' responses to the task was an effective approach for enhancing teachers' knowledge of students' learning because it provided the teachers with the opportunities to share insights of students' learning when they discussed students' responses to the tasks. The finding is consistent with the previous research on assessment integral to instruction (Chambers, 1993). However, the assessment tasks integral to instruction referred to in the study were characterized by the tasks conducted by the researcher collaborating with classroom teachers. The tasks referred to in previous studies are either designed by researchers only, or the assessment is merely a test at the end of instruction. Comparing to assessment tasks developed by individual, sharing multiple perspectives of appreciating the value of each task in a school-based assessment team was more likely to enrich the purposes of task and broaden the varieties of task.

The task dealing with problem posing allowed teachers to gain insights into the learning trajectory students constructed mathematical understanding. Likewise, more tasks dealing with students' misconception seem to be likely to enable teachers to make immediately remediation for the improper or misconceptions. The tasks displaying various solutions that students resolved for a problem helped teachers examine the individual understanding to one another's' methods. Therefore, the tasks designed in the study provide more opportunities for students to clarify and extend their understanding and for teachers to gain knowledge of students' thought and make

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them inform decision-making of teaching. The classroom discourse on mathematical ideas became a major resource of conducting such kind of assessment task. As a result, this contributed the teachers to optimizing the quality of assessment and instruction, and thereby optimized the learning of the students.

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